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Paul

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Demonstration and
Communication System
Architecture Description

2-1160-96DV-009-1

Wireless Aircraft Communicator (WAC)

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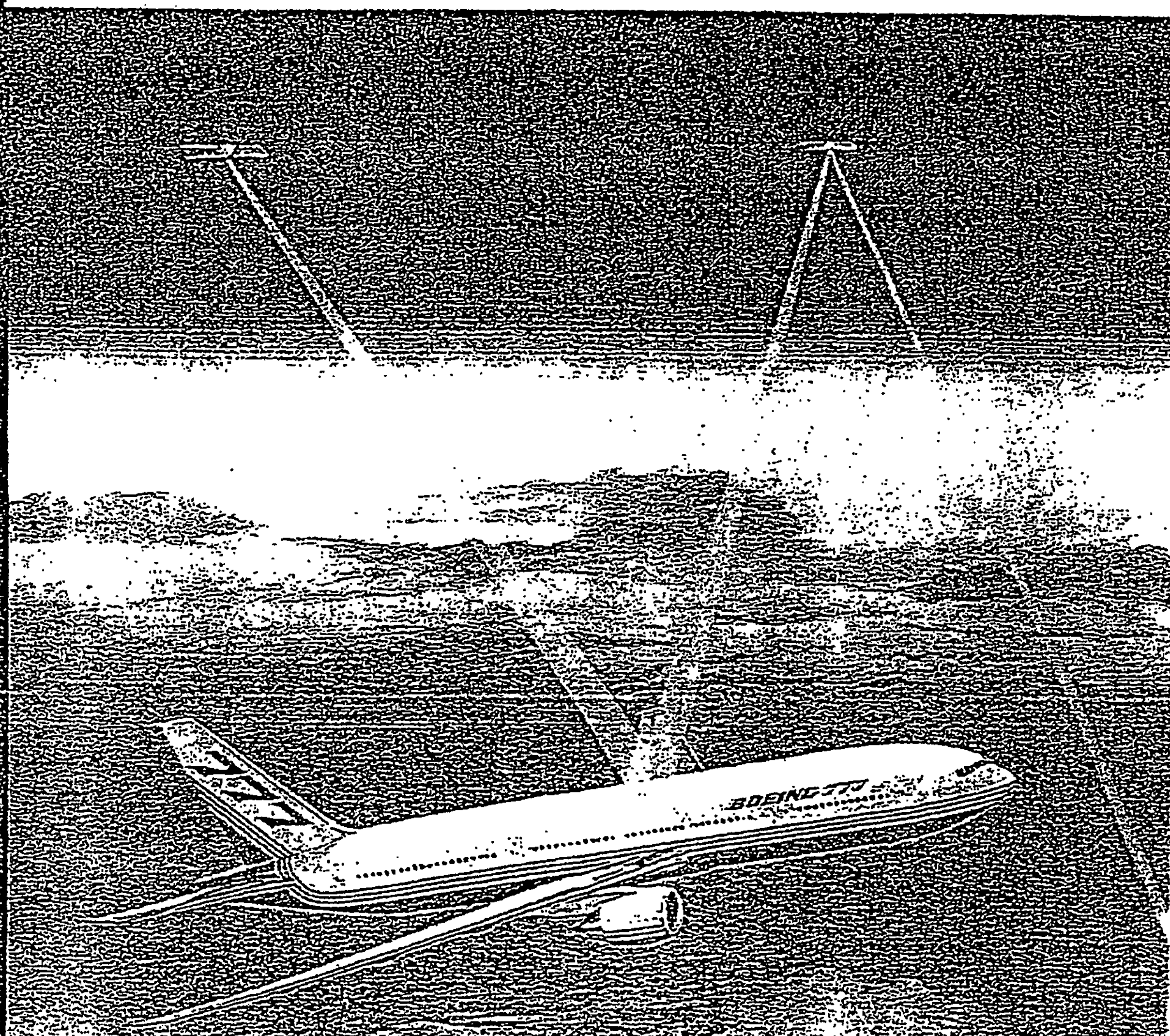

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Wireless Aircraft Communicator (WAC)

Demonstration and Communication System Architecture Description
2-1160-96DV-009-1

[redacted]

Submitted to:
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1.0 Introduction
2.0 Operational Services
3.0 Demonstration Phase
4.0 Summary

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CONTENTS

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FIGURES

ACRONYMS

A/C	aircraft
BCSC	Boeing Commercial Space Company
BIT	built-in test
BSS	broadcast satellite services
CDI	Computing Devices International
CDMA	code division multiple access
CONUS	Continental United States
COTS	commercial off the shelf
DBS	direct broadcast satellite
FACTS	flight attendant comments tracking system
FOQA	flight operations quality assurance
FMS	flight management system
FSS	fixed satellite service
IFE	inflight entertainment
INS	inertial navigation system
IRS	inertial reference system
ISDN	integrated services digital network
JWID	Joint Warrior Interoperability Demonstration
LNB	low-noise block
MB	megabytes
MMIC	monolithic microwave integrated circuit
MTBF	mean time between failure
N/A	not available
POTS	plain old telephone service
RF	radio frequency
TCP/IP	transmission control protocol/internet protocol
TDM	time division multiplex
UHF	ultra high frequency
USSB	United States Satellite Broadcasting
WAC	wireless aircraft communicator

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1.0 INTRODUCTION

Boeing Commercial Space Company (BCSC) is pleased to have the opportunity to respond to the Delta Air Lines vision for improving customer services.

The BCSC response to the Delta tenders principally addresses the Wireless Aircraft Communicator (WAC) tender Nos. 14-95, sections 3.0 and 5.0, 12-95, section 1.7.1, and 13-95, section 1.5.1. Our system concept would interface with the Delta fleet wireless aircraft communicator onboard equipment and the Delta-TransQuest ground systems.

BCSC is also responding to the Delta requirement for aircraft reception of live television, as applied to Distributed Entertainment applications to wide body aircraft under tender No. 12-95, section 1.4. While not specified by Delta for application to the narrow body fleet, this capability could interface with existing and proposed Inflight Entertainment system distribution architectures for narrow body-type aircraft.

BCSC intends to support any teaming/partnership Delta selects for both aircraft systems integrator/WAC suppliers and coordination with inflight entertainment (IFE) suppliers (tender No. 14-95, section 4.0). We have already offered ~~a nonexclusive agreement to Honeywell/CDI~~ for application of the BCSC-developed satellite communication system in response to the Delta requirements. We also intend to support Delta and the selected systems integrator in the fleetwide installation and integration of the proposed aircraft-to-ground communications system.

BCSC will support a Delta prototype in-service evaluation on one aircraft (narrow or wide body) in the timeframe proposed in section 3.3 with Boeing prototype aircraft communication equipment (nonblack label). The in-service performance evaluation will be subject to a contract to be negotiated with Delta within 1 month of award.

1.1 Delta Air Lines Vision for Wireless Communications

BCSC understands that the Delta initiative for improving customer satisfaction primarily focuses on the key "touch points" between Delta personnel and the passenger from ticket reservation to airport terminal gate departure/arrivals and inflight services. Consumers today are experiencing an information explosion through such sources as the Internet, electronic mail, multimedia services, and teleconferencing, and versatile and interactive entertainment using high-quality digital audio and television. Customer expectations for improved airline entertainment and inflight services are increasing. Delta's main objective is to bring the information environment to the passenger with less workload to ground and flight service personnel, while improving data management efficiency. Other objectives are to provide more versatile and interactive cabin management and inflight entertainment service and to standardize and consolidate all airplane "nonessential" information in the wireless aircraft communication system for narrow and wide body fleets.

Achieving these objectives requires a new Delta communications system architecture, as illustrated in figure 1.1-1, which addresses two-way operational and passenger services and live video for inflight entertainment. This vision translates into the data requirements shown in figure 2.1-2.

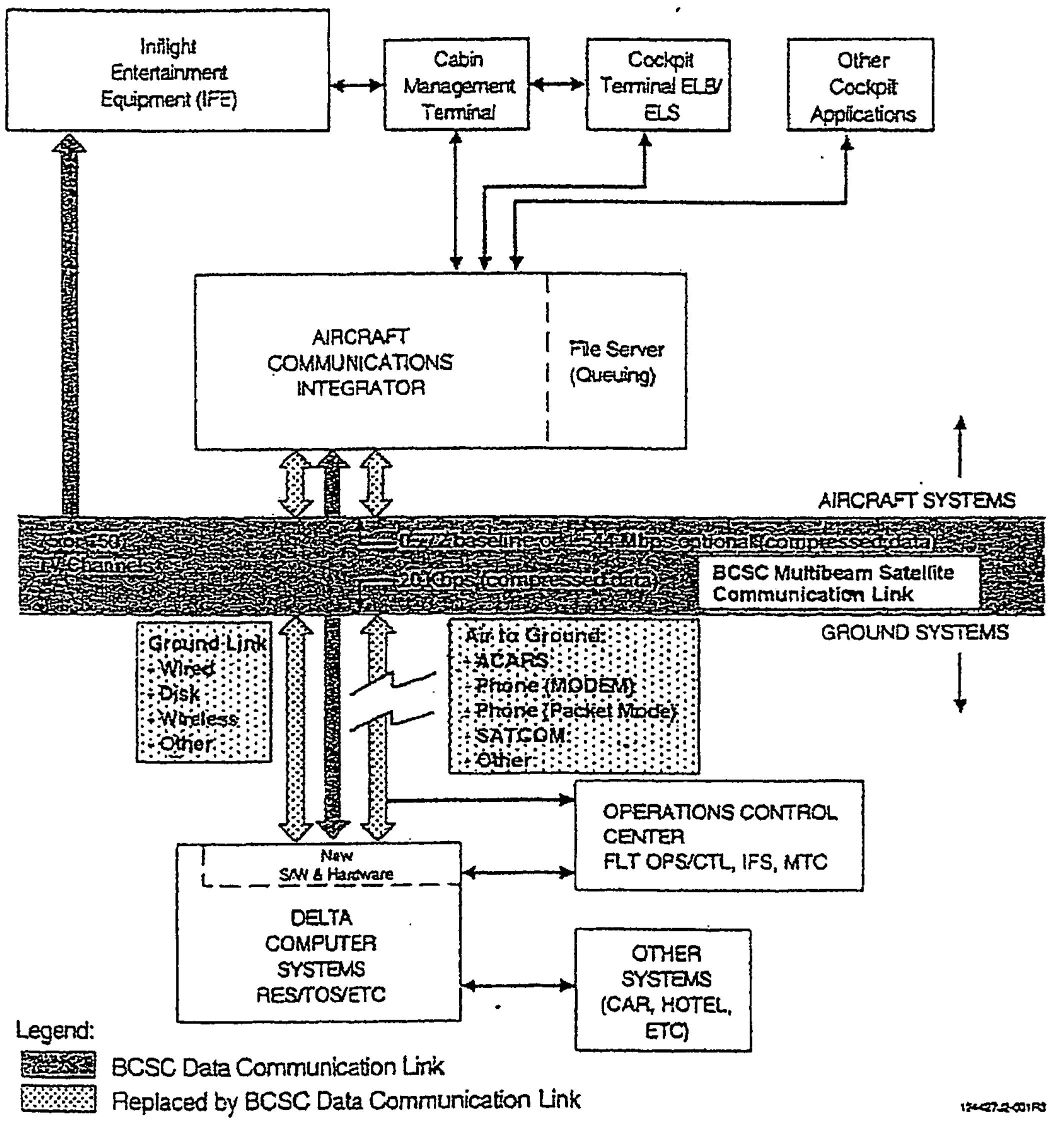

Figure 1.1-1. Delta Air Lines System Architecture

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The Communications Problem. Current communication channels serve these data requirements poorly, if at all, offering only a small fraction of the desired rate of data distribution through existing airborne unrelated systems. High-rate data can be passed through the Gate Link system, but only when the aircraft is physically connected to the gate. Because it requires transmit/receive equipment at every gate, the capital expense associated with Gate Link is formidable, if not prohibitive. Over-the-horizon wireless links, such as ACARS and UHF SATCOM (Inmarsat), offer inflight communications, but with a very limited data rate and at very high cost per bit. Terrestrial radio frequency (RF) telephone links are expensive, unreliable, and limited to the continental United States (CONUS). Satellite television is becoming a reality, but cannot be incorporated in any of the above systems, and thus requires a separate antenna installation.

The ideal solution, which BCSC is able to offer, would be an over-the-horizon wireless system with adequate band width for expandability and low cost, with the ability to accommodate two-way communications between Delta hub operations and the aircraft fleet through one data link and service provider and one antenna system per airplane. This same antenna would enable Delta to obtain inflight television from any direct broadcast provider and provide entertainment to its passengers.

1.2 The BCSC Solution

The BCSC solution to Delta's vision consists of a multibeam satellite communication link that will provide all the desired services through a combination of fixed satellite services (FSS) and broadcast satellite services (BSS) Ku-band satellites, continuously connected to every aircraft through a single low-profile phased-array antenna. Two-way operations and passenger service communication will be provided through an FSS satellite. This concept is illustrated in figures 1.1-1 and 2.1-1. The shaded area of figure 1.1-1 illustrates the BCSC air-to-ground communication link that could replace more conventional systems listed in the dotted boxes.

BCSC will provide all FSS satellite services, receiving uplink data from Delta and transmitting downlink data back to Delta via a dedicated land line, providing Delta with 24-hour "fiber-line like" services to all its domestic aircraft. Inflight television can be obtained directly from any one of a number of providers, including DirecTV, USSB, MCI, and EchoStar.

The key enabling technology is the Boeing-unique multibeam phased-array antenna, which is capable of simultaneously tracking and communicating with both FSS (for data transmission) and BSS (for live television) satellites. Unlike conventional antennas, the Boeing antenna can track multiple satellites simultaneously, without moving parts. It has a very low profile with virtually no effect on aircraft handling characteristics and fuel consumption. Because it has no moving parts, the BCSC phased-array antenna offers low maintenance and high reliability.

BCSC offers a fully compliant, expandable turnkey solution that provides low-cost communications with minimal aircraft hardware. The system is capable of delivering ALL the data specified by Delta (fig. 2.1-2) at the requested daily rates.

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The BCSC solution has potential for global coverage and capacity expansion. Because of the high bandwidth inherent in Ku-band satellite communications, the BCSC solution has adequate capacity to handle both ground and airborne data requirements and to move data at a significantly lower cost per bit than older, narrowband approaches. The worldwide availability of Ku-band satellites offers the potential to accommodate expanded data rates and extend coverage beyond CONUS. Rather than requiring a multiplicity of antennas and boxes to interface with a number of narrowband communication links, the BCSC multibeam phased-array antenna enables several different types of communications through a single low-profile antenna. The proposed combination of technology and services offers a cost-effective solution unequaled by conventional approaches.

1.3 The BCSC Team in the WAC Program

BCSC will provide the overall ground/satellite transmission services between Delta-TransQuest ground operations and the Delta aircraft fleet and will provide the aircraft antenna system that will interface with the Delta wireless aircraft communicator onboard equipment. See attachment A for company organization and related experience.

~~BCSC will be responsible for providing—~~

a. ~~Message delivery service (including ground station operation/maintenance and lease of satellite service; interface with the WAC system integrator), and interface with Delta-TransQuest (customer ground operations at Atlanta).~~

b. ~~Antenna system hardware/software.~~

c. ~~Support to [illegible] WAC systems integrator~~ for aircraft installation, ~~[illegible] to support certification.~~

d. ~~Supports to the IFE supplier for aircraft interface of live television with the onboard entertainment system.~~

BCSC assumes that Delta and the selected systems integrator will provide fleetwide aircraft certification and live television programming.

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2.0 OPERATIONAL SERVICES

Summary. Boeing has invested heavily over the past 10 years in developing low-cost, low-aerodynamic-drag, high-bandwidth, long mean time between failures (MTBF), multibeam phased-array antennas. The antennas represent critical technology for world coverage of mobile platform satellite communications applications. This antenna technology and the advances in high-power Ku satellites allow for a cost-effective high-bandwidth system that meets the requirements of the Delta WAC initiative.

The BCSC high-bandwidth satellite-based communication system described herein is designed to support the Delta vision for a WAC system that reliably and cost effectively provides continuous two-way performance throughout Delta domestic routes—in the air and on the ground. The system provides two-way data from the Delta Atlanta hub to and from each airplane 24 hours per day via a dedicated satellite infrastructure covering all of CONUS.

BCSC will support the Delta demonstration plan in the [redacted] of [redacted] using existing satellite/uplink assets available today. The applications developed for demonstration, combined with experience acquired in the demonstration, will be applied to the operational service, starting in the [redacted] of [redacted]. The dual beam receive phased array allows immediate reception of selected entertainment services from the high-power BSS satellites while simultaneously receiving and transmitting high-rate data from a medium powered and lower cost FSS satellite. Some of the system features are itemized in figure 2.0-1.

- Single wireless link-one infrastructure
- Always available (24 hours per day)
- Communicate real-time and archival data
- Bi-directional
- High data rate, accommodates growth
- Expandable with airplane fleet
- Expandable beyond CONUS

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Figure 2.0-1. Features of BCSC Communicator Link System

The BCSC solution provides Delta with a cost-effective domestic route communications solution that is expandable to international routes over European and Asian landmass areas using existing Ku-band satellites and easily migrates to future ultra-high bandwidth satellite solutions.

2.1 System Architecture

The baseline Delta WAC system is illustrated in figure 2.1-1. Each Delta aircraft would be fitted with a BCSC multibeam phased-array antenna system. The antenna subsystem would provide three simultaneous, digitally controlled beams (two for receive and one for transmit) to (1) bring digital live BSS television to the airplane cabin, (2) receive Delta messaging, and (3) transmit Delta messaging. The message rate to each airplane in the air or on the ground is 772 Kbps simultaneous with TV reception and 1.544 Mbps without TV reception. The downlink message rate is 20 Kbps per airplane accommodated within 50 simultaneous channels (1 Mbps total). We believe this system will satisfy all Delta WAC needs—in the air and on the ground—far into the future. It provides up to 1.544 Mbps data capacity on uplink. Further, a satisfactory satellite-based solution over CONUS will facilitate a similar approach to Delta international routes, where such a system becomes the only practical alternative.

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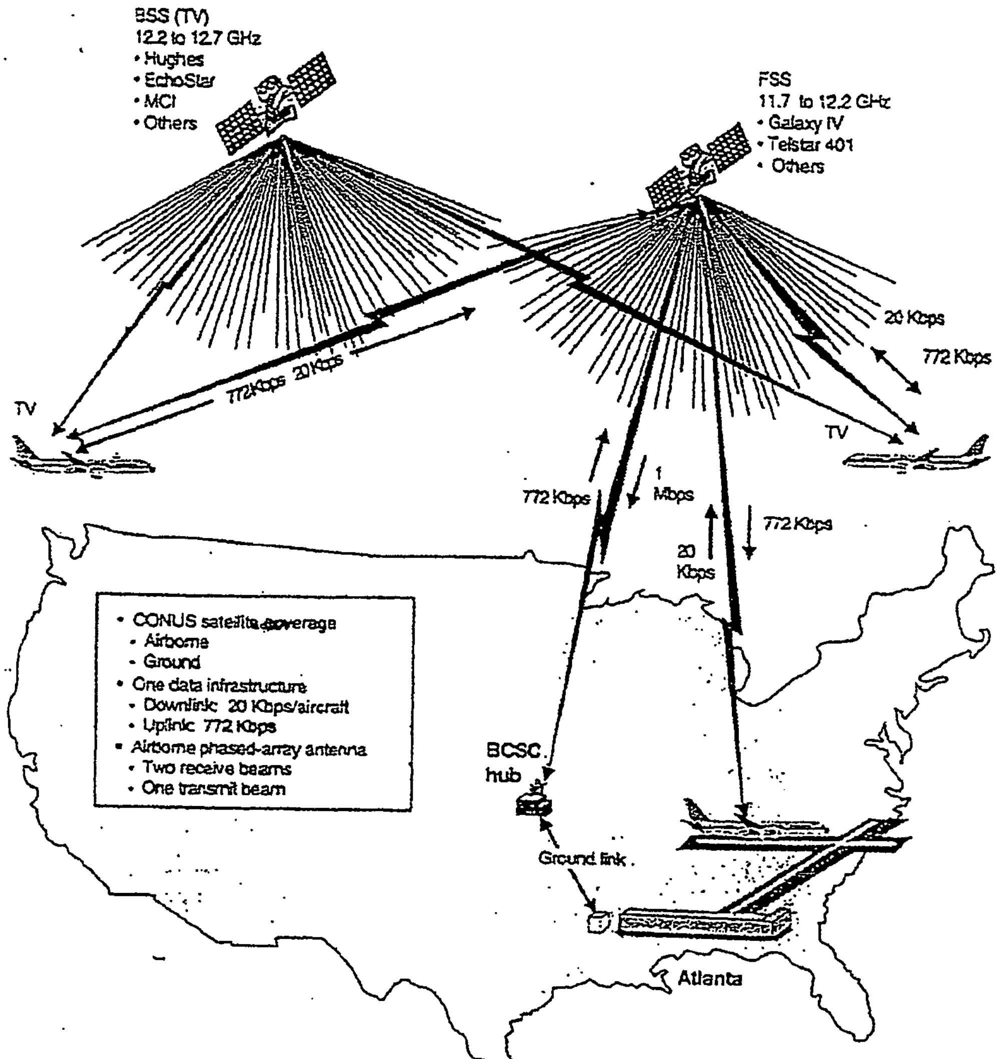

Figure 2.1-1. Proposed Wireless Aircraft Communicator (WAC)

Service Requirements. Figure 2.1-2 contains a list of Delta-specified files to be transferred to and from the aircraft along with the frequency of transmission. Most of the files are aircraft specific, one is aircraft model specific, and the rest are sent to all aircraft. The average data transmission for the fleet totals approximately 56 GB per day. By segregating the transmission into two categories, Delta suggests two message data rates for consideration: 20 Kbps at cruise conditions and 1 Mbps on the ground. The system is required to tie all of Delta's nonessential corporate airborne data communication efforts together into one central system. In addition, the WAC infrastructure will provide expandability for future applications that could be added with no hardware modifications necessary.

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BCSC Proposed Service. The BCSC system is designed to accommodate all of the Delta requirements for communications to and from each aircraft in the air as well as on the ground in one integrated system controlled by Delta in Atlanta. A specified capacity component of the system would be dedicated exclusively to Delta. It would operate continuously and would be installed, maintained, and operated by BCSC. Our multibeam antenna installed on each Delta airplane would be connected two way to the Delta hub via satellite. The communication link is completed by a ground link between the BCSC hub and the Delta hub in Atlanta.

Fixed satellite service (FSS) (Ku-band) has been selected to provide the most cost-effective solution for data communications to and from the individual Delta aircraft. Low-cost satellite capacity is available and we exercise control over all services using the transponder. FSS satellites will be used for the demonstration and production systems. We have developed a plan to acquire the necessary licenses from the FCC for the code division multiple access (CDMA) transmission for both the demonstration and production services.

The uplink to the aircraft would be sent throughout CONUS to each aircraft in a time division multiplex (TDM) format with the aircraft address preceding each message. Each aircraft strips off only messages addressed to that particular aircraft. Common messages, such as sports scores and shopping database, would be sent in a broadcast mode using an "all aircraft" address to minimize the time allocated to such requests. The Delta tender suggests that a message rate of 20 Kbps to each aircraft is adequate. Comparatively, Boeing is proposing a much larger pipeline: [illegible] Kbps of 2:1 compressed data that is shared by all aircraft to meet the Delta requirements. This is received into the cabin simultaneously with digital TV. As an option, the system could be operated at double this message rate, to 1.544 Mbps, by foregoing TV reception.

Downlink is accomplished from the aircraft to the FSS satellite for relay to the ground station and then on to Delta using a single T-1 telephone line. An instantaneous downlink data rate of 20 Kbps was selected. Analysis described above indicates that by sharing channels using TDM the number of simultaneous channels required to support 546 Delta aircraft is approximately 50 (with 2:1 data compression). The number of channels is achieved by using different frequencies and different user codes. Boeing proposes allocating 50 channels to the Delta WAC.

The BCSC solution offers near continuous communications connectivity. Aircraft located within a maintenance hangar may be linked in a wireless manner by installing two small dish antennas external to the building. These two antennas would be wired to two small radiators in the ceiling of the hangar to relay received and transmitted signals. Interconnecting electronics consisting primarily of RF amplifiers would be required to implement hangar operation.

Our proposed system fully supports Delta's requested data flow requirements. Our analysis shows that uncompressed full data flows can be accommodated using two transponders each for uplink and downlink. We believe, however, that the best overall solution results in one transponder each for uplink and downlink and a modest data compression of 2:1. We do not believe that additional compression is desirable, as it would increase risk significantly without significantly reducing cost.

Our analysis is summarized as follows: The configuration employs one uplink transponder and one downlink transponder. The data transmission requirements reflect maximum sizes and frequencies of transmission (fig. 2.1-2). We assume that the actual traffic will have an average utilization rate of 71% (rms averaging). We also assume that the data to be transferred is not precompressed. A 2:1 compression ratio is therefore easily obtainable. The uplink is capable of transmitting 772 Kbps while the downlink has a capacity of 50 channels of 20 Kbps each. The uplink is capable of providing 772 Kbps of data throughput. Using the assumptions above, our analyses indicate 39.7% extra capacity. This extra capacity could be used to satisfy the multimedia on-demand upload that was specified TBD in the requirements.

The downlink has one dominant data traffic generating component called marketing/financial tracking data. This component is sent from each aircraft four times per day and is 10 MB. Discussions with Delta personnel have indicated that 4 MB would be a sufficient size. Again, using the assumptions above, at 4 MB we show a 6% margin.

To optimize system performance, certain efficiencies in addition to compression would be incorporated into the WAC message protocol. When data is transmitted to all aircraft, we propose to broadcast the data simultaneously to all aircraft as often as appropriate. The system would transfer large dedicated files using the following mechanisms: (1) breaking up the file and transmitting in increments (smaller pieces) throughout the day as link capacity permits, (2) scheduling transmissions of some files at night and early morning hours when the data rate could double, and (3) sending only the required information with the operating software, background, and forms resident within the aircraft.

The system is simple and powerful. Since the ground link and the airborne link is the same system, there needn't be any distinction between the two services. Files that might ordinarily be transferred only on the ground may now be transferred at any time. Additional capacity may be provided to either the uplink or the downlink as required. The airborne equipment does not change as the system is expanded.

2.2 Aircraft Element

The BCSC phased-array-based communication system provides a continuous high-speed data highway to link each Delta airplane. The aircraft element consists of a top fuselage-mounted antenna, converters to process the received and transmitted high-frequency signals, and a controller to manage the satellite selection, satellite tracking, and system operation. This configuration provides both live TV in flight, plus continuous two-way data communications to the on-airplane data management server.

As depicted in figure 2.2-1, the required interfaces to the aircraft data management server/router are the received data (up to 1.5 Mbps), the data to be transmitted at a rate of 20 Kbps, and a control/status interface for such functions as satellite selection, on/off control, and built-in test (BIT) status. Additional airplane interfaces are input power (3-phase 115V ac, 400 Hz) and input from the inertial reference system (ARINC 429) to define airplane heading and attitude.

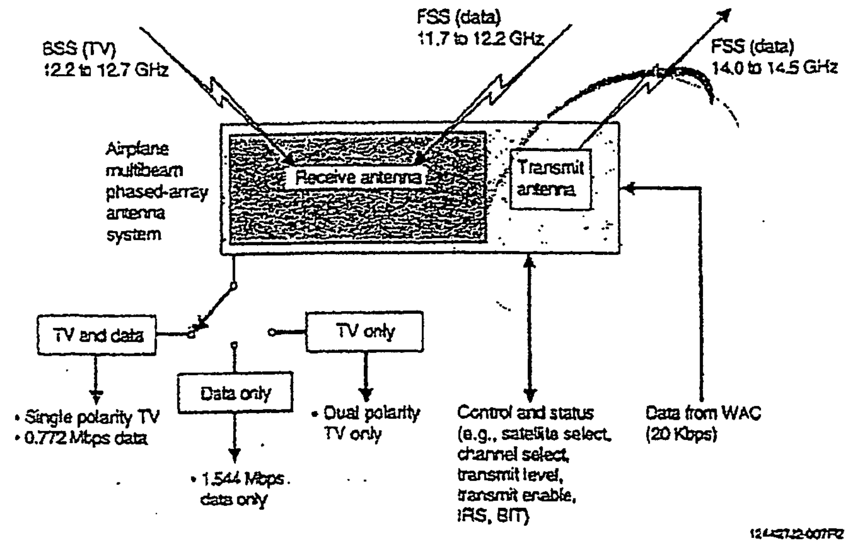

Figure 2.2-1. Aircraft Antenna Functional Diagram

The key element of the aircraft equipment is the phased-array antenna, which electronically multiplexes signals from up to 1,500 individual radiating elements to produce a coherent beam without moving parts. These individual elements are electronically "steered" (i.e., have their relative phasing adjusted) to initially select and, subsequently, track the target satellite of choice.

For the receive function (data or live TV), the antenna "points" at the appropriate satellite under command from the controller. The controller maintains the correct pointing, even while the airplane is moving by continuously scanning the area near the target and re-aiming at the "hottest" spot, the satellite source of radio-frequency power. Because of the high update rate (1kHz), the antenna remains fixed on the target even during turbulence-induced airplane motion. Output to the data management server is via a high-speed data bus. Live TV RF output is provided to BSS-compatible receivers, which is a part of the IFE system.

For the transmit function, the controller uses the receive beam to aim the transmit beam and adjusts the required element phasing to point the beam at the satellite. The data input to the transmitter is on a high-speed data bus.

The detailed elements of the aircraft communications equipment are shown in figure 2.2-2.

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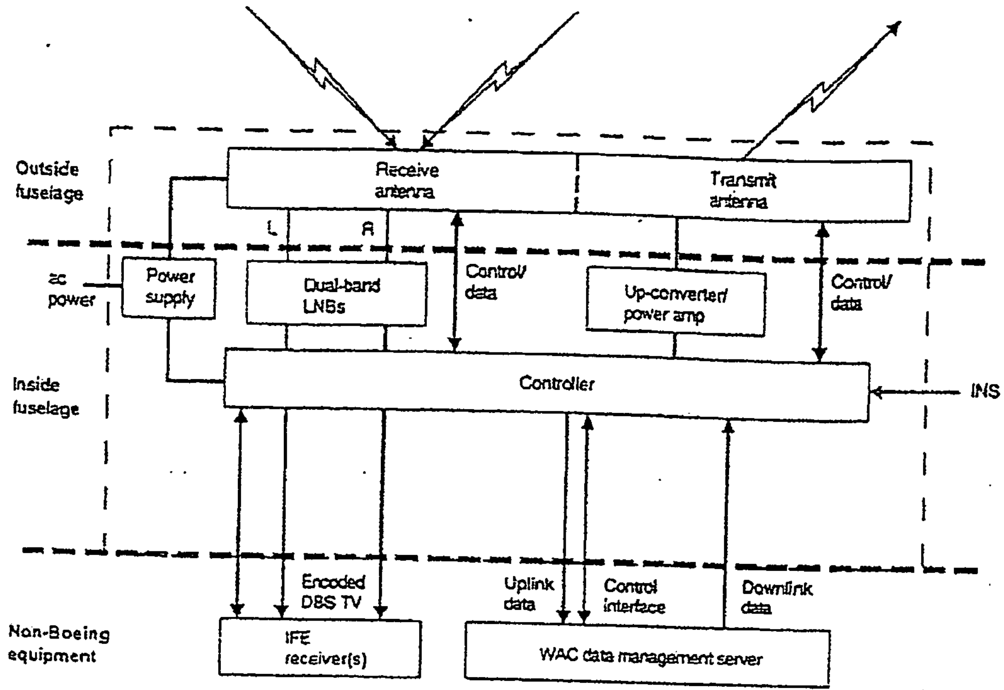

Figure 2.2-2. Aircraft Element Internal Architecture

2.3 Ground Element

BCSC will furnish and operate a dedicated ground station facility with both uplink and downlink capability for Delta. The ground station will be located conveniently to optimize the required communications links. Figure 2.3-1 illustrates the overall ground element architecture, including the land line connections to and from the Delta hub and the satellite uplink and downlink services to and from the aircraft.

Uplink Services. The communication protocols used for the uplink and downlink services are dependent on the message service architecture. The ground system architecture assumes a data packet stream in which the destination aircraft is specified in the packet header. Packets are delivered to anywhere from one to the entire fleet of Delta aircraft. The satellite-delivered uplink can communicate with aircraft in the air, at the gate, on the taxiway, or in a hangar (with dish antenna and repeater on the hangar).

Downlink Services. Downlink data channels are assigned to specific aircraft on a dynamic basis using an "order wire" channel. When message traffic is ready to be downloaded, the aircraft requests a channel on the order wire and the ground station allocates an available channel and sends a message to the aircraft specifying the channel assignment. The aircraft then "tunes" to the specified channel and begins transmitting the preformatted data. Each of the 50 20-Kbps data channels is reconstructed and multiplexed into a single 1.0-Mbps data stream and routed to the Delta hub on a dedicated T-1 land line connection.

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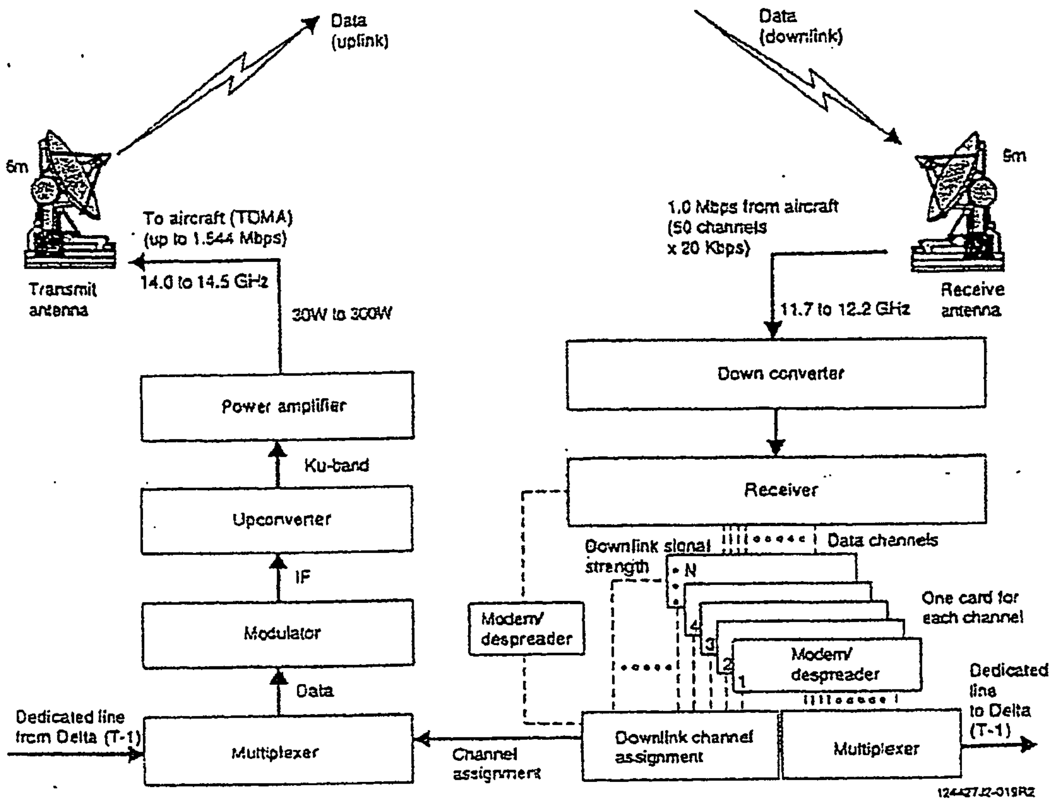

Figure 2.3-1. Ground Element Architecture

2.4 Message Service

The BCSC system solution for message service is designed to satisfy two high-level goals: (1) meet the currently identified Delta requirements at the lowest total overall cost and (2) design and construct the system in such a way that substantial future growth can be accommodated via incremental capacity increases with only a minor effect on infrastructure.

The BCSC message service assumes that the Delta data will arrive at the ground station via a T-1 data link. The ground station will receive the data, process the signal, and then automatically uplink the data to the entire fleet, both in the air and on the ground, over the Delta domestic route system. Delta-TransQuest will provide routing instructions as a message header for message delivery and then transmit. Message service routing/addressing can be (1) fleetwide, for a single message transmission, (2) selected characteristic, such as fleet type-specific (757s, MD-80s), engine type-specific (CF6-80, PW4000), or hub/destination/connection, and only those flights impact by a weather event, or (3) individually, such as by tail number or flight number.

BCSC service would operate 24 hours a day and could delay non-time-critical messages to nighttime or off-peak periods. File transmissions, especially large files, can be spread over time in order to reduce peak bandwidth requirements because of the unique seamless nature of the ground to airborne operations of the BCSC message service.

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BCSC will work with Delta and TransQuest to determine an optimal solution to the data management and queuing requirements and interface with legacy computing and communications infrastructure. It is estimated that the reassembly (demultiplexing) of the downlinked data can be accomplished with networked commercial off-the-shelf (COTS) PCs. A similar system, using PCs for this function, has already been designed and implemented by BCSC.

While some software development will be required, we plan to use pieces of existing systems to assist in the implementation of this function.

BCSC has assumed that all messages to be uplinked would emanate from the Delta Atlanta operations hub and all downlinked messages would be delivered over the same T-1 link.

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3.0 DEMONSTRATION PHASE

Key elements of the demonstration phase relevant to the communications link proposed by BCSC are (1) reception of the flight management system (FMS) database (1 MB), (2) transmission of the flight operations quality assurance (FOQA) data (32 MB) and flight attendant comments tracking system (FACTS) data (1 MB), and (3) reception of live TV from direct broadcast satellites (DBS).

The proposed demonstration will show the following capabilities:

a. Continuous data reception at rates of 0.77 Mbps while in flight (cruise mode) and on the ground. At 0.77 Mbps, the maximum file size of 1 MB (FMS database) would require 10 seconds to transmit. The data highway may not be available during all takeoff and landing maneuvers.

b. Continuous data transmission at 20 Kbps while in flight (cruise mode) and on the ground. The maximum data file (FOQA) of 32 MB would require 3.6 hours to transmit. While the data highway may not be available during all takeoff and landing maneuvers, the availability of this link at all other times reduces the necessity of a much higher speed ground "burst" to satisfy the requirement to move 32 MB, which is consistent with the ground operations requirement to receive 2 GB in 4.5 hours at a rate of 1 Mbps.

c. Continuous live TV reception while in flight (cruise mode), with reduced capability during takeoff and landing maneuvers or while on the ground. Continuous operations using DirecTV or USSB are expected near and on the ground in Atlanta because of the much higher satellite signal over Atlanta compared with other CONUS locations. Weather conditions will determine availability on the ground.

3.1 Demonstration Architecture

The prototype system would be functionally similar to the production system. The selection of the space element drives the selection of transmit and receive frequencies and data rates. The associated aircraft hardware element for the antenna will be as close to the production system as possible.

The Delta prototype demonstration will link the demonstration airplane to an FSS satellite to receive data at rates of up to 0.77 Mbps at 11.7 to 12.2 GHz, transmit data at rates of up to 20 Kbps at 14.0 to 14.5 GHz, and also receive live television from a BSS service provider (DirecTV or USSB), as shown in figures 3.1-1 and 3.1-2.

3.2 Demonstration Equipment

3.2.1 Aircraft Element

Figure 3.2-1 shows the prototype phased-array antenna for BSS TV reception. A modified version of this antenna will be prepared using antenna elements capable of simultaneously receiving both data and TV reception from two different satellites. Figure 3.2-2 shows how the

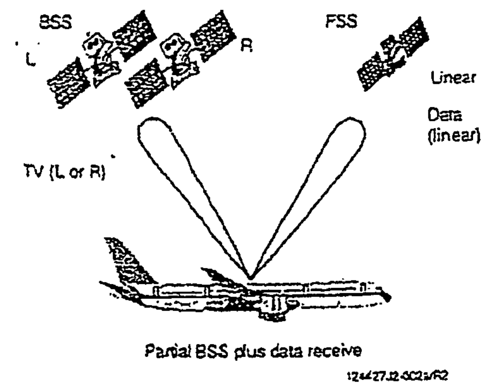

Figure 3.1-1. Receive (Data and TV)

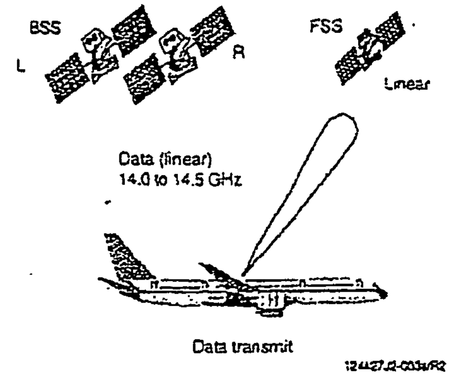

Figure 3.1-2. Data Transmit (to FSS)

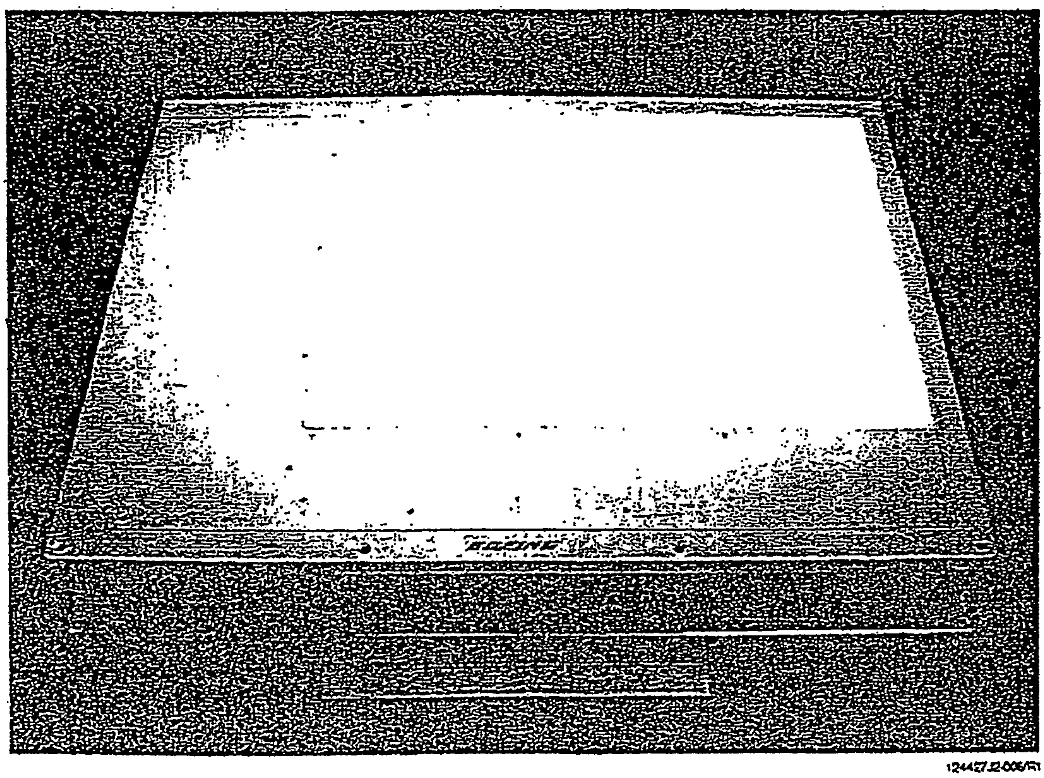

Figure 3.2-1. Direct Broadcast Ku-Band Phased-Array Antenna Prototype (24" x 34.5")

[redacted]

antenna is mounted on top of a narrow body airplane. Figure 3.2-3 illustrates a functional architecture for the demonstration, indicating the key antenna system functions outside and inside the fuselage, together with proposed interfaces to the WAC and IFE functions. Figure 3.2-4 illustrates an estimate of the airborne equipment weight and power requirements for a demonstrator system.

All other airborne hardware is functionally similar to the production system, using components in development at this time for the airborne BSS TV service. The TV antenna equipment is scheduled for initial flight demonstrations at Boeing [redacted].

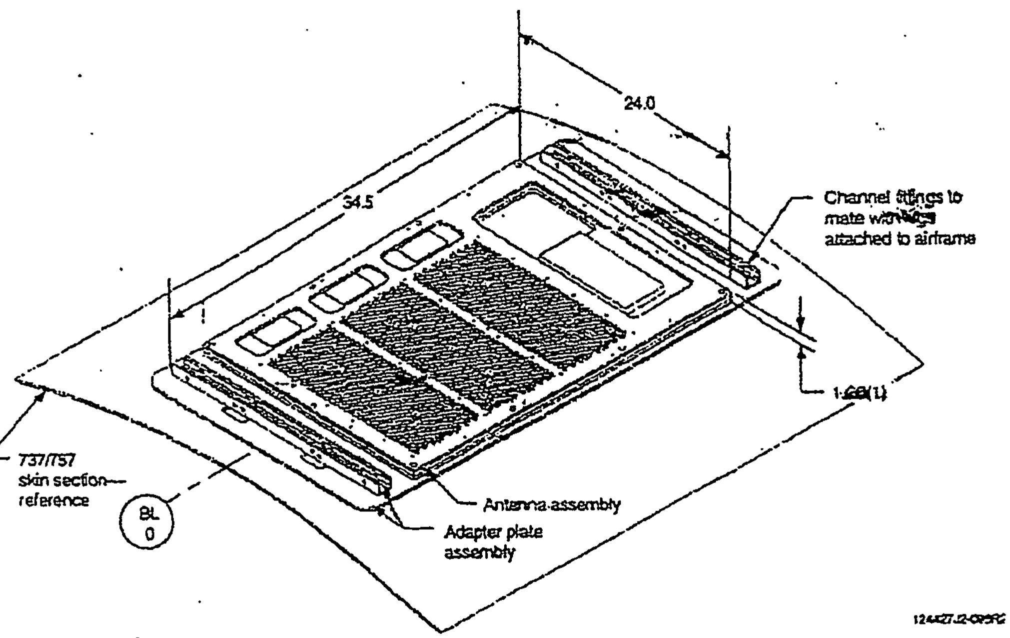

Figure 3.2-2. Installation of BCSC BSS TV Phased-Array Antenna on Aircraft

3.2.2 Ground Element

To implement the ground station function for the demonstration phase, BCSC will rent a satellite communications equipped van, which is readily available and normally used for transmitting and receiving TV news broadcasts. To simplify the demonstration, the van will be collocated with Delta facilities at Atlanta.

The Delta data submission/transmission will consist of using several content provider computers (PCs) running software that performs content submission and scheduling of the desired data, a "fire wall"/router, file servers, and transmit electronics and hardware (including modulator, transmitter, and the transmit antenna). The demonstration ground station consists of transmit and receive functions. The ground station receiver function will consist of an antenna, electronics (including a low-noise block (LNB) converter), demodulator, and PC. In actual

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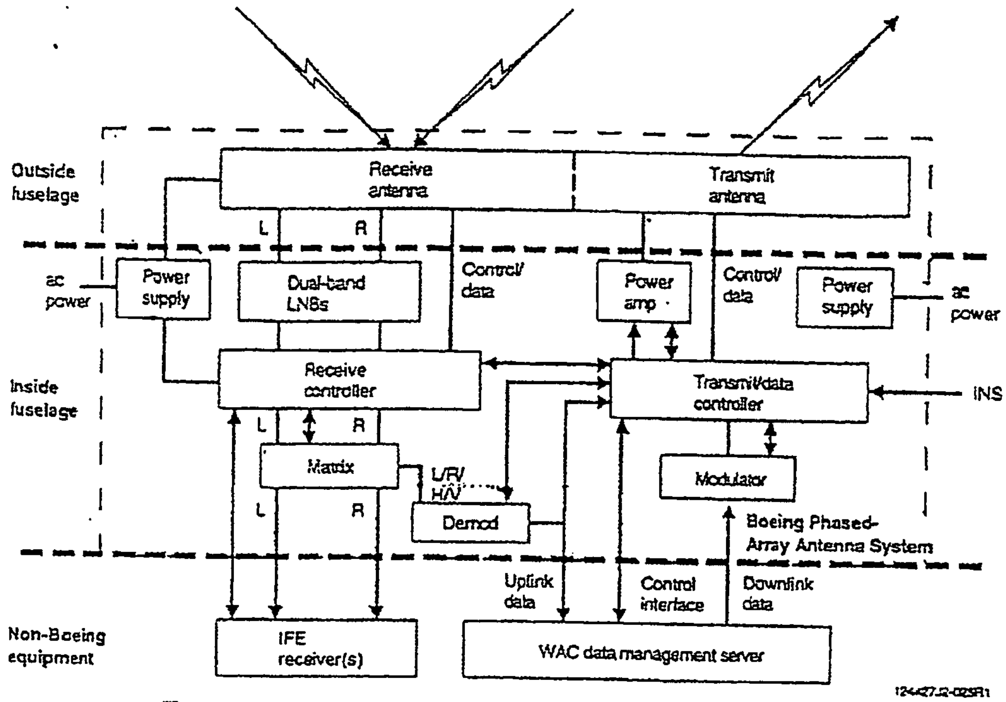

Figure 3.2-3. Aircraft Element Demonstration Functional Architecture

LRU	Weight	Net power
Receive antenna	100	330
Receive controller	8	30
Receive power supply	15	158
LNB	2.5	9
Cables	25	0
Total receive	150.5	527
Transmit antenna (est.)	30	50
Transmit controller (est.)	8	20
Transmit power supply (est.)	5	30
Power amp/Up-converter	5	33
Demodulator	30	100
Modulator	2	21
Cables	25	0
Total transmit	105	254
Total demo	255.5	781

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Figure 3.2-4. Estimate of Demonstration Antenna System Weight and Power (Production Power Goal 20% Lower)

operation, the received data would be forwarded to the appropriate computer(s) on the Delta LAN.

Data communications between the ground station and other Delta locations can be implemented by the optimal use of direct network connections (e.g., Ethernet at 10 or 100 Mbps), floppy disks, magnetic tapes and CD-ROMs, and dedicated phone lines (e.g., 56 Kbps, T-1) and dial up phone lines (POTS, ISDN, Fractional T-1).

BCSC has implemented a ground station using the industry standard TCP/IP protocol (for data backhaul) using ISDN and T-1 phone lines as well as the Internet. This experience will help produce an effective solution for Delta.

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3.2.3 Message/Satellite Services

The demonstration is proposed to take place over a 30-day period. BCSC believes this period is sufficient to demonstrate large file transfers (uplink and downlink), and prioritized scheduling of high- versus low-priority data.

Specific Delta data requirements for the prototype evaluation require 10 seconds per transfer for FMS database uplink and 3.6 hours to downlink the FOQA data, plus 7 minutes to downlink the FACTS data after each flight. The available data channel can be used for additional applications and data items as Delta chooses. While extending the length of the demonstration longer than 30 days will increase the cost of the demonstration, BCSC is willing to negotiate a longer demonstration period.

3.3 Demonstration Schedules

The top-level WAC schedule is shown in figure 3.3-1. Development of the dual polarization BSS receive capability is proceeding independently of the Delta proposal.

The date for development of the antenna system and message service for the demonstration, [redacted] is based on a [redacted] program go-ahead. The production schedule is proceeding concurrently with long-lead procurement and red label design. Black label delivery to meet Delta's large-scale installation plan requires a Delta contract award by [redacted].

3.4 Demonstration Assumptions

Our demonstration proposal is based on the following assumptions:

a. Up to 1 week at the beginning of the prototype 30-day evaluation period will be used for equipment installation unless the aircraft is available prior to the beginning of the evaluation period.

b. Delta will select the aircraft model (Boeing 757 or 727) and provide definition of the aircraft mechanical and electrical interface drawings for the airplane ~~to be used~~ for prototype evaluation, including all applicable WAC and IFE interface data, within 1 month of the award letter to allow development of the equipment and installation design.

c. Delta will install the BCSC equipment on its airplane. We will provide technical support on site in Atlanta during installation.

d. Delta will provide the FOQA, FACTS, and FMS information (via electronic media) to be used for the prototype evaluation.

e. Delta will provide definition of the ground system interface to its operations and definition of the airplane interfaces to the data management server and entertainment system within 1 month of the award letter to allow development of the communications interfaces.

f. Delta will provide the ground system operations and the necessary technical support coincident with the prototype evaluation period.